Space Technology Research Grants

Study of Magnetic Nozzle Effects on Plasma Plumes

Completed Technology Project (2011 - 2015)

Project Introduction

As identified in the NASA In-Space Propulsion Systems Technology Area Roadmap, an efficient, high specific impulse, in-space plasma propulsion rocket engine is a key enabling technology for furthering NASA's goals in exploring the solar system and is one of NASA's Grand Challenges. To help develop this technology and enable NASA to meet its goals, I propose to study basic plasma flow in a magnetic nozzle, which is a critical technology required to optimize plasma rocket performance. Magnetic nozzles are important components of plasma propulsion devices because they help direct plasma flow, convert energy into thrust, and ensure efficient plasma detachment from a spacecraft. Immediate applications of magnetic nozzles include the Variable Specific Impulse Magnetoplasma Rocket (VASIMR), which will be tested on the International Space Station in about five years and is under consideration for enabling future NASA missions, including human exploration of Mars. My study of magnetic nozzle influence on plasma plume dynamics will consist of using the newly formulated Magneto Gas Kinetic Method (MGKM), based on kinetic theory, with additional development for multiple-species and an experimental study at the Texas A&M University Plasma Engineering and Diagnostics Lab. Using computational models and experimental prototypes, I will study magnetic nozzle performance by varying magnetic field strength and shape, as well as plasma density, pressure, and temperature. These coordinated computational and experimental efforts will allow for a more complete examination of the complex interplay between fluid and electromagnetic forces that affect a plasma in a magnetic nozzle. This research will help improve our knowledge of basic physical processes and provide guidelines for optimal design. The significance of the proposed work is that it addresses NASA's need to develop a key technology required for efficient in-space transportation, one that will be absolutely essential for both human and robotic solar system exploration missions in the future.

Anticipated Benefits

These coordinated computational and experimental efforts will allow for a more complete examination of the complex interplay between fluid and electromagnetic forces that affect a plasma in a magnetic nozzle. This research will help improve our knowledge of basic physical processes and provide guidelines for optimal design. The significance of the proposed work is that it addresses NASA's need to develop a key technology required for efficient in-space transportation, one that will be absolutely essential for both human and robotic solar system exploration missions in the future.

Project Image Study of Magnetic Nozzle Effects on Plasma Plumes

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Organizational Responsibility

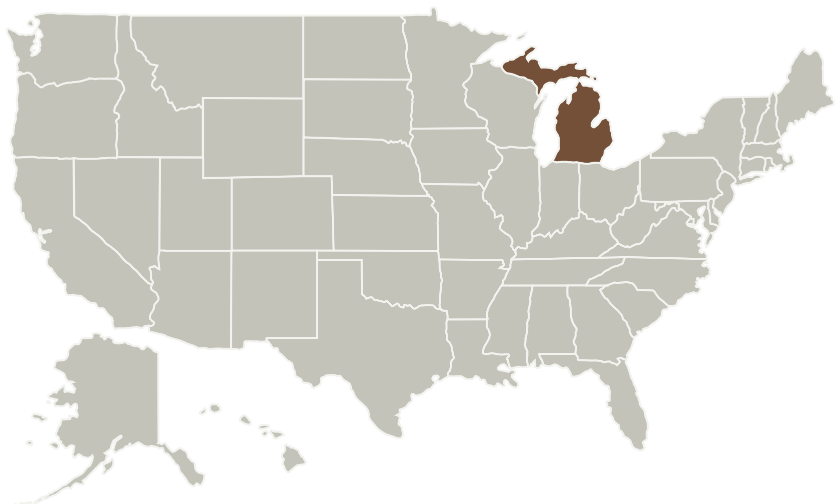
Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Michigan-Ann Arbor	Supporting Organization	Academia	Ann Arbor, Michigan

Primary U.S. Work Locations
Michigan

Project Management

Program Director:
Claudia M Meyer

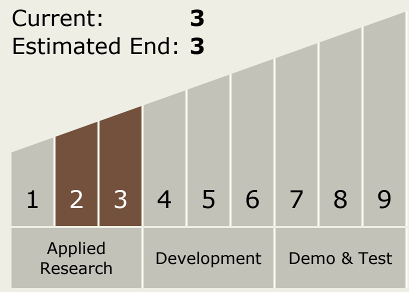
Program Manager:
Hung D Nguyen

Principal Investigator:
Benjamin Longmier

Co-Investigator:
Frans H Ebersohn

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX01 Propulsion Systems
  └ TX01.2 Electric Space Propulsion
    └ TX01.2.3 Electromagnetic

Images

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Project Image Study of Magnetic Nozzle Effects on Plasma Plumes
(https://techport.nasa.gov/image/1828)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html